

**ECE 403**  
**Senior Design II**  
**Options Considered Document**

**10/3/12**

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## Introduction:

John Ihle is our locally based client who wants a location based solar tracker. This involves designing and developing a controller that can be retrofitted to a dual-axis solar photovoltaic tracker system. The device inputs should be the time of day and a person's latitude and longitude to determine and control optimal panel positioning. The system should be relatively inexpensive and possibly be adaptable to fit other tracker systems.

## Previous Works:

### Wattsun

Array Technologies manufactures Azimuth Trackers for medium-to-large residential PV systems. Our Azimuth Tracker gear drive rotates the PV array on the pole mount so the bottom edge of the array always remains parallel to the ground. The result: a low profile and exceptional stability in the wind. A Dual-Axis Tracker enables automatic tracking of the sun's elevation as well. Dual-axis trackers completely capture all the power the sun delivers.

- AZ-225 Azimuth Gear Drive
- Dual-Axis Included
- Mounts up to 3500 Watts
- Up to 225 Sq. Ft. of PV array



Wattsun active trackers are environmentally-friendly and are guided by a patented, optical, sun-sensing device that dramatically outperforms passive tracking systems. Solid state electronic design and positive drive mechanisms insure consistent operation in extreme temperatures and windy conditions.

### SunTracer

SunTracer has a dual axis solar tracker. It can have an elevation angle from 15-90 degree. It makes use of the linear motor SM4S900M3 with stroke of 900mm. The tracking accuracy is less than 0.5 degrees and makes use of the protocol TdAPS (Time derived Astronomical Positioning System). It is possible to connect to a PC through USB. It can operate in temperature from -25C to 75C and withstand wind speeds from 130km/h.



## SunTura

The main tracker mount holds two linear actuators and this is what moves the solar panels throughout the day. The main tracker mount is constructed from 6061 aluminum and stainless steel fasteners. The linear actuators are each rated to move 225 pounds of weight and each linear actuator can hold up to 450 pounds of static weight. One water-tight, epoxy sealed electronic sun tracker board ("the brain") is used for the controls. The brain is a solid state electronic control board which utilizes their proprietary software to track the sun with sub-degree accuracy and precision. The brain also has three manual switches mounted on it. Two of the switches allow you to manually move the tracker north/south/east/west and the third switch turns the tracker on/off. Manual maneuvering of a tracker is very convenient when you want to access the solar panels for cleaning or to position the solar panels parallel to the ground during extremely high winds. Four photo sensor mounts onto your tracking system. The four photo-sensors collect light from the sun and the brain uses this information to move the two linear actuators to track the sun.



## Solaria

Structurally certified to withstand wind loads of 90mph (145 km/h) in all directions with an autonomous controller. Only one controller required for every 750kW for greater reliability. This is only a single axis Azimuth tracker which makes use of a double worm gear unit with a 3 phase AC motor. The controller is PLC-based that monitor position.



## Design Options:

The following list includes part that we will use and the advantages and disadvantages. There is also a reason for why we choose the part.

### Method of powering:

The solar tracking in place has a 24V power line in place that will would tap off of to power our controller.

### GPS:

Linx Technologies: Digi key P/N RXM-GPS-SR

#### Advantages:

- Low Power Consumption
- -40C to 85C
- No programming necessary
- Outputs data: Longitude, Latitude, Time, and altitude
- Battery backed SRAM
- Uses up to 20 satellites
- No external RF components needed
- Uses TX and RX lines

#### Disadvantages:

- Surface mount only
- Needs power supply noise to be less than 20mV to be accurate

- Have static sensitive parts in it
- Cost(\$50)
- Needs to be away from noisy devices on PCB

We are choosing this GPS module because it has the necessary data outputs that we need and the temperature that it can handle. This was also one of the more simpler GPS module with least amount of pins that will need soldering for testing purposes. It did cost more but we can handle that if it make it a little simpler.

### **Regulator:**

LM2576/LM2576HV Series - SIMPLE SWITCHER® 3A Step-Down Voltage Regulator  
24V to 5V LM2576T-5.0-ND

Advantages:

- The regulator guarantees a 3A output current
- Wide input range to compensate for power fluctuations
- High efficiency
- Thermal shutdown protection
- Fixed frequency internal oscillator
- High Temp Thresholds

Disadvantages:

- Output Voltage Ranges from 4.8-5.2V

We are using this part to bring our 24V power supply down to 5V useable power supply for our components.

### **5V Precision Regulator:**

Texas Instruments – (LP2550-50LPRE3)

Digi Key P/N 296-20933-2-ND

Advantages:

- Very accurate for 5V (2%)
- Low dropout Voltage of 380mV
- Wide input range up to 30V
- Current and Thermal Limiting features

Disadvantages:

- Low output current

This is need for powering the GPS module. The GPS module needs a low noise power supply to be accurate.

## **Digital Compass:**

3-Axis Digital Compass IC - HMC5983

Digi key 342-1092-1-ND

Advantages:

- -30C to 85C
- Make use of I<sup>2</sup>C lines on PIC
- Up to 3.4MHz speed on I<sup>2</sup>C
- 1 to 2 degree accuracy
- 12-Bit ADC Coupled with Low Noise AMR Sensors
- Software and Algorithm Support Available

Disadvantages:

- Will have unused temperature sensor ability
- May require more software time to get to work
- Surface mount

This will be used for orientation purposes. With this, we will know which way is easy, west and the elevation of the device.

## **Microprocessor:**

Microchip PIC18F4620

DigiKey P/N PIC18F4620-I/P-ND

Advantages:

- Used before in class Familiar with microcontroller
- Comes with a compiler
- Has enough ports to handle our devices
- Has a boot loader
- Cost effective
- Optimized C language Compiling
- -40C to 125C

Disadvantages

- Does not have built in Trig functions
- In comparison to other chips it is fairly large in size

This component is going to be the brain of our project it will be in charge of doing calculations and running the entire project it will have to send and receive from both the GPS unit and the digital compass and tell the motors to rotate accordingly

## **Power Transistors:**

Diodes Inc : Digi key P/N ZTX1049A

Advantages:

- Voltage: 25V
- Current: 3A
- Power : 2W
- -55C to 150C

Disadvantages:

- 300mA at 3 Amps

These transistors will operate the motors but because the PIC is only able to output a maximum of 20mA so we will need some other transistors that the PIC can control to be able to turn the power transistors on and off.

## **Transistors:**

Diodes Inc: Digi key P/N ZTX688B

Advantages:

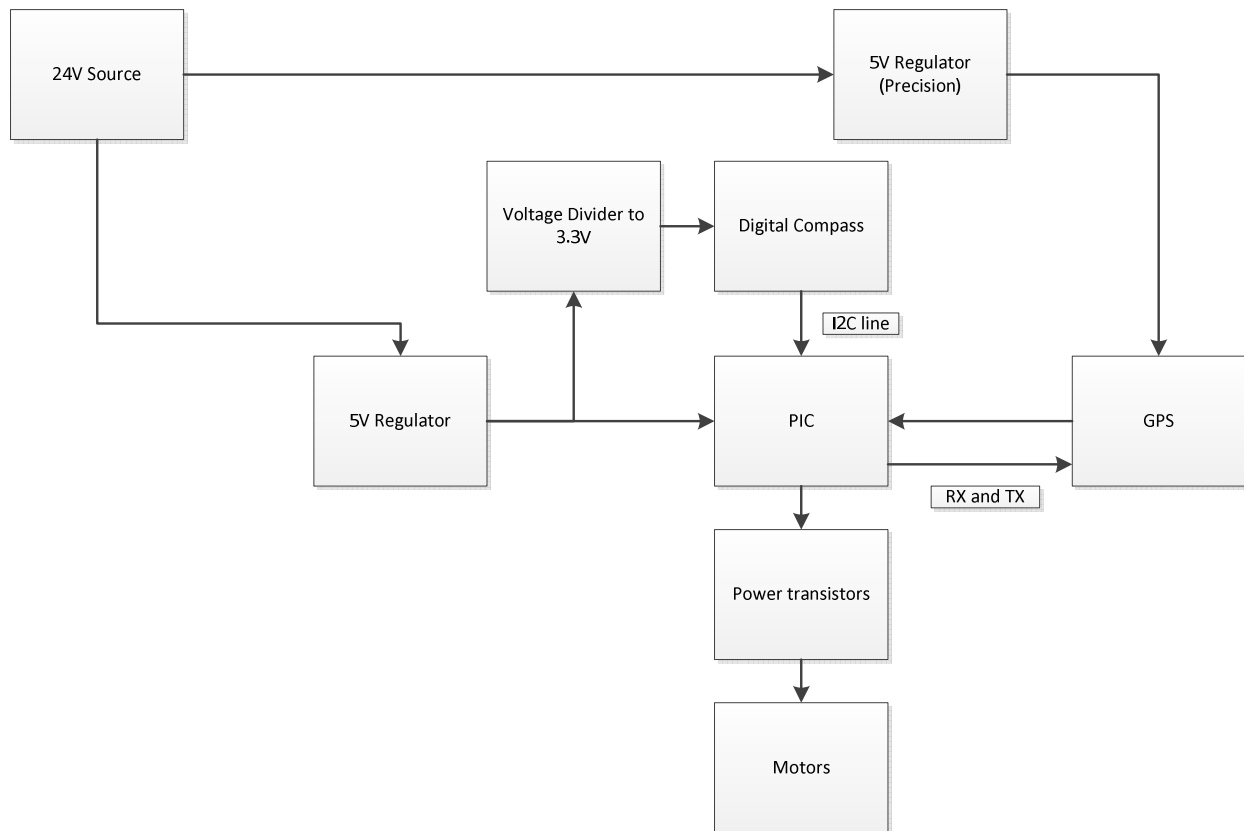
- -40C to 150C
- 2A
- Input voltage from 1.8V to 5.5V

Disadvantages:

- Might be too much current only need 300mA

The PIC would be able to control this transistor and this part could also be power by the 5V regulator.

## Block Diagram:





## Budget:

Item #	Item Description	Price per Unit	Quantity	Total Cost
1	PIC Microcontroller	\$30	2	\$60
2	Precision Regulator	\$1.50	2	\$3
3	Voltage Regulator 12V-5V	\$8	4	\$32
4	GPS	\$50	2	\$100
5	Components	\$60.00	1	\$60
6	PCB	\$50	1	\$50
7	Digital Compass	\$10.00	2	\$20
8	Motors	\$180	2	\$180
9	Power Transistors	\$0.75	4	\$3
10	Transistors	\$0.45	4	\$2
			Total	\$510

## Timeline:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Requirements Capture meeting					x											
Requirements Capture Document						x										
Options Considered							x									
Order Parts								x								
Make Schematic in Multisim									x							
Program PIC										x						
Breadboard PIC (maybe w/o sensors)										x	x	x				
Interface w/ sensors and motor										x	x	x				
>>> Sensors											x	x				
>>> PIC											x	x				
>>> Motor											x	x				
Progress Report:												x				
>>> Progress on PIC												x				
>>> Progress on motor, and enclosure												x				
Revise Schematic in Multisim												x				
Start PCB layout in Ultiboard													x			
Finalize PCB layout (Ultiboard)														x		
Prepare for presentation															x	
Presentations, end of semester																x

Since there is only two people working on this project, We will be doing everything together as a group and split the task up if the need arises.

## **Summary:**

We have shown that we have many options to consider in the construction of our controller. Many of our decisions for this project involve what we believe is necessary to create a device that is reliable and efficient. Our goal in this project is to maximize the reliability and efficiency with our provided budget. We have shown in our timeline that we plan to have a working prototype of our controller by the end of the semester. We will spend the following semester making and testing a prototype.

The solar tracker controller that we provide for the John Ihle will be able to solve the problem of location base tracking.

